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Color me Impressed: Using Lexical Decision Task to understand Color-Word Associations

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by

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Abstract

Color Psychology is defined as “the study of how various hues, or colors, affect people and their behavior”. (Ungvarsky, J. 2021) Colors extend past everyday life, when used properly, can greatly influence our behavior. Evidence supports that color is associated with emotions and emotion-laden words. This study tests whether colors would activate food related or optimistic thoughts. In this study, utilizing the Lexical Decision Task, participants were asked if words were in fact words or nonwords, after being primed with one of three colors: red, yellow or gray. It was hypothesized that when primed with red, participants would identify a food-related word as a word faster than in other colors. And that when primed with yellow, participants would identify an optimism-related word as a word faster than in other colors. My findings did not support this hypothesis, but did provide further evidence in the role of varying color and how that can influence behavior, response time. Additionally, the automatedness of these color word-associations are discussed and what can be done to understand these relationships.

Color Me Impressed:Using Lexical Decision Task to understand Color-Word Associations

INTRODUCTION

The sky is blue, the grass is green, and depending on who you ask, the dress is white and gold. Color is just about everywhere you look and turn, unless you find yourself in a dark theater watching an avant-garde black and white film playing, in that case, I am unsure where the color has gone. Color can play a role in tradition by wearing black during a funeral and a white wedding dress. If you've watched a fair amount of cartoons, you've seen color help when expressing reactions, perhaps when a character gets mad you'll see their face go red before their head explodes right off. Additionally, if you're having a hard day you might describe yourself as "feeling blue". Overall, color is just about everywhere, whether in a traditional sense, a descriptor, to show expressions, odds are you probably even have a favorite color. And because color is such a prominent part of our lives, there might be even more to color worth exploring such as how the usage of color can affect our responses and how color does this.

Color Psychology is defined as "the study of how various hues, or colors, affect people and their behavior" (Ungvarsky, 2021). To explain the ideas of Color Psychology and how they directly relate to my topic, I will first provide insight into how associations may be formed through emotions and colors. I will follow that up with how color is used in real-world situations like marketing and presentation. Finally, I will explain the Lexical Decision Task, and how I will utilize it to further understand color-word associations.

COLOR + ASSOCIATIONS

How exactly does someone “feel blue”? Blue in a very literal sense is a collection of values making up hues, saturation and lightness. Although blue may not directly be an emotion it’s a common saying that does indicate a feeling of sadness. Therefore in order to “feel blue” it relies on the association between the emotion sad and the color blue. So to begin, we do associate color with emotions. Sutton and Altarriba(2015) found that the color Red was most associated with negative emotions and emotion-laden words such as enraged, hostile, tense, and danger. While yellow was most associated with positive emotions such as astonished, friendly, and cheer. These are interesting findings because they provide evidence that color is associated with certain emotions. Their goal was to design a database of color associations and they did so by providing color associations for 160 different words that across the board showed how certain emotions hold color associations. Red’s association to negative emotions can also be supported by further evidence from Gilbert and colleagues (2016) which found that words like anxious, tense, angry and irritated shared a common color association with red. These words also shared a common color association with darker shades of red as well. They also found that words like romantic and sensual shared a color scheme of bright pinks and reds, generally happy emotions. This supports previous findings that brightness generally plays a role in emotion associations, that positive words such as agile, ambitious, and dream will be associated with brighter objects (Meier et al., 2004). Which Sutton and Altarriba (2015) also support by finding that negative emotions such as dreadful and helpless were most commonly associated with the color black. Overall, there is support for brighter colors being associated with positive emotions but also that generally, there are associations between emotions and colors.

It is worth noting that Sutton and Altarriba also categorized words into two categories: emotions and emotion-laden. Emotion-laden describes words that "do not directly label an emotional state" (Sutton and Altarriba, 2015) but may make you feel a certain emotion. This included words like death, infection, killer, punishment, etc. We can connect emotions, words that evoke emotions and color into a unit of sorts that work together. The association of death and killer leading to being most commonly associated with red, is made possible because of the already existing negative associations to the color red such as tense, danger and hostile. Of course, we aren't born knowing these series of associations, the study points out how this can be taught through conditioning at school when teachers would use red ink to make corrections on papers and exams (Sutton and Altarriba, 2015). These associations are reliant on exposures in order to be developed. In order to associate the color red to killer, we need to have been taught that red was a sign of danger to begin with.

COLOR IN MARKETING + PRESENTATION

Color is used in marketing in all sorts of ways. Odds are, color is what influenced you to buy several products you have around your home. Perhaps it was a conscious decision by going with your favorite color or maybe it was an unconscious decision, through the means of color. For example, the popular fast food restaurants McDonalds, Burger King, and Wendys share a common similarity within their logo. A logo, a key marketing tool, that can help distinguish a brand. Their logo shares the color red, which will increase your hunger and attention (Kersar, 2010). And they are not the only restaurants to use this idea in their logo, Chick-fil-a, KFC,

Sonic's does as well. Because the color red induces thoughts of hunger (Kersar, 2010) it can be assumed that there's an association between both the color red and hunger.

Despite several websites: businessinsider.com, dailyinfographic.com, dvo.com claiming that red does make people hungry, these claims are made without citing a source. And because of this, little information is given about why this happens. While red may induce hunger, the process in which this occurs is simplified across these websites, but instead is a slightly more elaborate process than just red leads to hunger. Oh et. al (2021) suggests warm colors, such as red, can lead to an increase in heart rate and skin sensitivity. This was found by studying individuals' stress levels and these reactions to a color like red demonstrate how color is fully capable of stimulating the body. By stimulating the body and mind, blood begins to flow. The blood flow works to keep it circulating in order to maintain a higher metabolism. Which will ultimately end in individuals feeling hungry. Websites such as,dailyinfographic.com and dvo.com, have failed to provide empirical evidence in their references as to why red induces hunger. Only when broken down into the process: Red is a stimulant, which gets the mind going, leads to blood circulation, and ends in hunger induced individuals, does an association between two makes the most sense. There is a potential association between red and hunger, and this emphasizes the importance of further research exploring hunger-related stimuli and it's possible association with the color red. One possible explanation for this lack of evidence, could be explained by how the color red might be able to prevent hunger.

Although there seems to be questionable evidence to support that red induces hunger, that doesn't change the fact that there seems to be a favorable effect of using red for restaurant logos.

One additional explanation could relate to biases of individuals as it relates to color and food. According to Foroni et. al (2016), when comparing red and green foods, it is perceived that green foods have less energy in comparison to red foods. Additionally, participants were more aroused (the want for the shown food/item), towards food that contained more red than food that contained more green. Individuals appear to have a bias towards the color red, at least in comparison to the color green.

Currently, red seems to be positively influencing behavior, but there are certain associations with red that induce negative emotions (Sutton and Altarriba, 2015). According to Goenshaw and colleagues (2015), the color red can reduce how much people eat snacks and drink. (Genschow et al. 2015) These results were found by presenting snacks on a red plate and beverages inside of a red cup, and comparing that to plates and cups colored blue. One possible explanation for this outcome is due to avoidance motivation, that because the color red is associated with danger, and other “negative possibilities' ' which could include a stop-sign or flashing red light warnings. (Elliot et al. 2009) This is shown by Elliot and Colleagues (2009) when they found that when red is shown on a test cover, participants would move their body away from the test packet much more than when presented with a green or gray test packet.

So the color red not only induces hunger but can also stop us from consuming food and physically moving away from the color red. It sounds paradoxical because restaurants want you to come to them so using red in their logo to induce hunger is good yet at the same time the color red can have the opposite effect by stopping you from eating. The multiple associations of the color red, highlights the complexity of colors and demonstrates how many different ways color can influence our behavior. And it is particularly an area of interest, because previous research

has focused on red and its negative associations (Elliot et al. 2009, Genschow et al. 2015, Sutton and Altarriba, 2015). But when a clear positive association like inducing hunger is possible and there is a lack of confirmation of this association, it is worth exploring.

And red is only one of many colors that holds many associations. And in my current study, it will look at very particular word-color associations in order to gain a better understanding of those individual associations. However, these multiple color-word associations extend past just red and yellow. For example, the color blue may be associated with negative moods such as sad and unhappy, but also positive ones like grateful and relaxed (Sutton & Altarriba, 2015). And as shown in the research done by Goenshaw and colleagues (2015), the color blue, when compared to red plates and cups, can also be used to encourage eating and drinking. An insurance company like Allstate can use the color blue to help induce ideas of comfort and trust, because "you are in good hands", and that would be reasonable, as blue induces feeling calm, due to its ability to relax individuals over the color white . (Minguillon et al., 2017) According to a logo analysis conducted in 2017, in the logos of the Fortune 500 companies, they found that 51% of them had a shade of blue present (EPCGroup, 2017). Nurses often wear the color blue, we would like to trust the nurses attending us and we want to have an overall positive experience. And as found by Albert and colleagues (2013) that blue nurse uniforms were most associated with positive feelings and emotions such as calm and relaxed, especially in comparison to that of a white uniform, which made them feel mixtures of scared and worried.

Blue is a multi-functioning color, just like red, that with its multiple associations can be used effectively to brand a company and be used in the everyday hospital setting to ensure

patients are relaxed. A great deal of research (Albert et al. 2013, Genschow et al. 2015, Minguillon et al., 2017) has been done exploring the complexity of the color blue and both of its positive and negative associations, but the same can't be entirely said for the color red. Red is the subject of this study, to further analyze the color-word association it has with hunger inducing stimuli.

Presentation is important, and can influence the perception of food. (Piqueras-Fiszman et al., 2012) In order for you to even plate a delicious meal at home, these items must first make it off the shelf at the store. And this is how we see the impact of using the color yellow. Ares and Deliza (2010) found that yellow packaging was more associated with sweet vanilla desserts versus the black packaging that was more associated with bitter flavored desserts. This supports previous research that showed how a bright color like yellow can invoke positive emotion-inducing words (Sutton and Altarriba, 2015) such as sweet, and how black can induce negative emotion-inducing words such as bitter (Sutton and Altarriba 2015). These results show us how packaging color can influence expectations for milk desserts. Had a sweet vanilla milk dessert brand opted for a black packaging over a yellow packaging, it could have risked inducing negative expectations such as disgusting or bitter. It is safe to assume that no one prefers something that tastes disgusting or bitter, so to prevent those potential expectations, colorful packaging can be used.

We see evidence of this in a study from Marques de Rosa and colleagues (2018) found that packaging designed in a red-to-yellow gradient and blue-to-green gradient packaging were both preferred in comparison to the gray-scale packaging. However, the red-to-yellow packaging was perceived as more sweet than blue-to-green and gray-scale packaging, which demonstrates

how expected taste can come courtesy of packaging color (Marques da Rosa et al., 2018). It also provides additional support for yellow serving as a color that may evoke positive emotion-inducing descriptors like sweet and how manipulating packaging color can create different expectations and associations. While it may appear now that Yellow could potentially have an association with hunger-related stimuli, this information is presented to highlight not just the relationship between yellow and positive traits, but also how with a better understanding of color-word associations, effective packaging can be created. Color is an important factor in how it is to perceive something, and therefore manipulating color can lead to interesting findings.

Sucapane and colleagues (2021) looked into the role of packaging color and how that affects the perception of plant based and meat alternative products. They conducted the experiment by taking packaging associations such as “plant-based” being associated with green and “meat alternative” with the associated packaging color: red and they decided to flip these combinations and analyze those effects, which they called “mismatching”. The findings were interesting as they found that when matching meat-alternatives with the color green instead of red, led participants to think it was less eco-friendly (Sucapane et al., 2021). This is interesting because the researchers expected the opposite result, that by pairing it with green, a color associated with health and eco-friendly, it would lead to participants viewing it as more eco-friendly. However, they did find that when plant-based was paired with the color green, it would decrease predicted satiety, the feeling of being full and satisfied, in comparison to when it was mismatched with the color red, due to “healthy foods being perceived as less tasty”. (Sucapane et al., 2021).

While matching(mismatching) packaging colors with certain associations can lead to vary results such as in their study, overall, their findings suggest that “varying packaging color can change the nature of the relationships between product descriptors and consumer perceptions and behavioral intentions” (Sucapane et al., 2021). This is important to our present study, as we explore a similar idea of matching colors to certain commonly associated words, and also mismatching them with two entirely different colors. But by manipulating these colors, we create new color-word relationships that could present results based on our word-stimuli, or could otherwise be entirely influenced by the fact the colors are varying.

LEXICAL DECISION TASK

The Lexical Decision Task presents a string of letters, and it is up to participants to determine whether or not that string of letters is infact a word or not a word. This sounds like an easy task, but when completed, can be telling of how we process information and our reactions. On top of assessing for accuracy, theLexical Decision Task can be used to assess how quickly participants are able to make the correction distinction between the two options: word or nonword. Meyer and Schvaneveldt (1971) conducted a study where participants were shown two words, and asked if both words were in fact a word or nonword by responding with “yes” or “no”. Participants that were shown two words that shared an association, led to a faster response time than two words that did not share an association. This suggests that words that are more familiar in meaning, can be easily identified as a word versus words with no connection to each other. Therefore, a word association is able to “activate” participants' recognition of a word, and

lead to faster reaction times. And utilizing a related-word or non-related word to influence participants' reaction time is one example of a process known as priming.

Priming is an effect that occurs when exposure to a previous stimulus influences an individual's response to the following stimulus. In order for these stimuli to have a connection, it relies on our experiences. Experiences and information that we gather are stored into schemas within our memory (Camina and Güell, 2017). 'Schemas' as noted by Baddeley and Hitch (2010) refers to "well-learned processes that allow us to respond appropriately to the environment". Priming is successful because it is able to retrieve certain schemas from our memory, and activate those certain schemas of information much easier, which would include closely related words and associations. Priming indicates that particular schemas that are closely associated with each other can become activated all at once. And because they are all being activated simultaneously from our memory, participants would therefore be able to respond faster to the lexical decision task at hand.

Using the Lexical Decision Task, by looking at the reaction times component, I'm exploring how automated these color-word associations have become using primes. Because certain colors are associated with certain words, could these color word associations when served as a prime be automatic enough for participants to identify them as a word. Instead of priming by utilizing like words, the priming will occur by flashing a colored rectangle on the screen. Participants will be primed by the color, and if the word is associated with that color, participants will identify the word as a word faster than if done in any other color. The Lexical Decision Task will aim to confirm how these associations are formed, are they occurring so quickly and without

realization because of how ingrained they've become, or do these color associations only occur when they are apparent and clear.

In a study done by Margarida V. Garrido and colleagues (2019), they used a Lexical Decision Task to examine the relationship between red associated with stop, green associated with go, and if these color associations are still present when the words are not directly related to either stop and go. Specifically, they presented neutral words (unrelated to both stop and go) and a set of pseudo words in different font colors: red, green and gray. They were exploring how these unrelated color word associations, simply by being presented with these colors would be enough to influence response time. If green means go, and red means stop, could these pre-existing associations be enough to influence participant reaction times by leading to faster and slower reaction times, respectively. They found that neutral words, when presented in green, did lead to faster reaction times and when presented in red, led to slower reaction times. While this result highlights the automated nature of the color associations, as for Pseudowords, the opposite was the case and therefore putting the automated color associations into question. But overall, this study demonstrates that varying color across can shape our behavior and lead to different reaction times.

Garrido and colleagues (2019) stated that "colors should not be used as behavioral cues irrespective of the contexts or specific associations they maintain". This final point emphasizes the importance of color associations and specifically discourages mismatching color associations. My study builds on this idea by presenting stimuli, colored rectangles: red, yellow, and gray, that are in line with pre-existing color word associations (red + hunger-related words and yellow + optimism/positive related words), and determining if these are strong enough

associations that can influence participants reaction times. If color-word associations are automated, identifying them as words when said word is primed with its respective color, should lead to faster response times.

Method

Participants

40 participants ranging from the ages of 19 and 40 and were recruited through Prolific. Participants were paid to participate in this study for 15 minutes and were paid at a rate of $1.88. All participants stated prior to the experiment that they are not colorblind. All participants participated remotely on their home computers through the Gorilla™ online experiment builder (Anwyl-Irvine, Massonnié, Flitton, Kirkham, & Evershed, 2020; Bridges, Pitiot, MacAskill, & Pierce, 2020). All participants reported currently living in the United States and learning English as their first language. The following sample breakdown is based on data collected from those who completed demographic questionnaires, five participants did not complete the questionnaire. The sample includes 14 males and 21 females. The ethnicity breakdown was: White (91%), Black (11%), Asian-American (6%), and Multi-Racial (3%).

Materials

A total of 60 unique words are present in this Lexical Decision Task. The word breakdown was as follows: 10 hunger-related words, 10 optimism-related words, 10 neutral words, and 30 pseudowords. The words selected for Optimism, were words that reflected ideas of Optimism and Positivity, the words were adapted from Sutton and Altarriba's study, and this study provided evidence for color and word associations between Optimism/Positivity and

Yellow. This includes words such as: Joy, Friendly, Astonished,.. (see Appendix A for full List).The words selected for red were adapted from the association that red induces hunger, the words used were composed of adjectives and nouns that are commonly associated with food and hunger. This includes words such as: Tasty, Snack, Dish,... (see Appendix A for full List). The neutral words were compiled using a pre-existing set of words used in a Lexical Decision Task conducted by Frick and colleagues (2003). This list of words was made available on a document labeled "WORDS INVENTORY" and was available for download. These words were cross-checked in order to assure that there wasn't a potential association to the color red and yellow. This will include words such as: Call, Lift, Firm,.. (see Appendix A for full List). Pseudowords were generated using a pseudoword generator, and words were cross-checked to ensure they weren't randomly added to the dictionary. Finally, I cross-checked these pseudowords one last time to ensure they would not be associated with red or yellow. The list of pseudowords includes words such as: Papul, Slimpers, Slover,...(see Appendix A for full List).

Procedure

Participants participated in a block consisting of 180 trials, prior to seeing each word, participants were briefly flashed one of three colored rectangles on the screen, the three colors: red, yellow, gray. Prior to beginning the Lexical Decision Task, participants were asked to fill out a questionnaire. In order to be eligible for the study, participants had to confirm that they were not colorblind, once confirmed, they were able to begin. Next, participants completed a brief set of 12 practice trials. Only during the practice trials were participants given a checkmark or X that indicated whether or not they identified the word prompted on the screen as an actual word or nonword correctly. Once the practice trials were completed, they completed 180 trials, the words

were randomly selected and the colored rectangles were randomly prompted prior to each word. By the end of all trials, participants had seen each word prompted by all three colored rectangles once. This study lasted approximately 15 minutes. Upon completion, participants were thanked for their participation and compensated for their time.

Results

Data from 36 participants was analyzed, this data only includes reaction times that were in a 200-1200ms interval. Additionally, participants' data was removed altogether if they received below a 70% accuracy rate. Overall, participants scored well above that, minus two participants who scored below that. Those two participants were removed. When the individual mean of all reaction times were calculated, one participant held all the outliers, so that participant was removed from the data set. Finally, all participants were presented with 180 trials with unique word-color combinations, and therefore no color-word combinations were meant to be repeated, but due to a technical error, a participant received duplicates of trials and therefore did not receive all unique 180 trials. This participant was also removed from the data set.

Reaction Times - HUNGER RELATED ITEMS

A one-way ANOVA on Mean Reaction Times of Hunger-related stimuli with color primes as a within-subjects factor revealed a marginally significant main effect of color. $F(1, 36) = 2.58$, $p < .083$.

As shown in Figure one, Participants were numerically faster at identifying hunger-related words as words for yellow ($M = 863$, $SD = 150$) than they were for red ($M = 854$,

SD = 153). A post-hoc t-test found the difference was not significant (M_{diff} = -8.79, SE = 13.3, t(35) = -0.659, p = .789). However, also shown in Figure X, when the hunger-words were paired with gray (M = 834, SD = 133), in comparison to both red and yellow, participants identified them as words numerally faster.

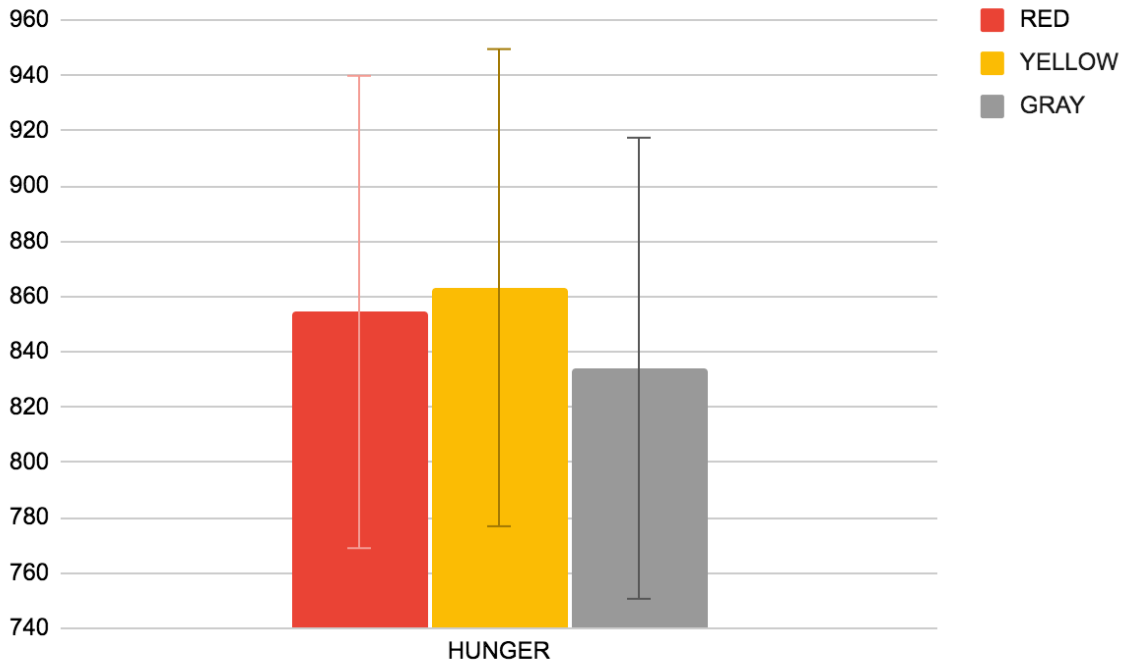

Fig. 1: Mean of all trial hunger-word related response times (ms) based on color.

The effect of color was not significant for red vs yellow: SE = 13.3, t(35) = -.659, p = .789 red vs gray: SE= 14.7, t(35) = 1.381, p > .05 but there was a significant main effect for yellow vs gray: SE = 11.2, t(35) = 2.604, p < .05. The expected result was that utilizing red would lead to faster response times, in comparison to yellow. While not the expected result, there is a significant difference between utilizing yellow and gray versus red and yellow when identifying hunger-related words faster.

Reaction Times - OPTIMISM RELATED ITEMS

A one-way ANOVA on Mean Reaction Times of Optimism-related stimuli with color primes as a within-subjects factor revealed a marginally significant main effect of color. $F(1, 37) = 2.60$, $p < .081$.

As shown in Figure two, participants were numerically faster at identifying optimism-related words as words for red ($M = 835$, $SD = 158$) than they were for yellow ($M = 869$, $SD = 171$). A post-hoc t-test revealed the difference was not significant ($M_{diff} = -33.25$, $SE = 19.6$, $t(35) = -1.698$, $p = .220$). Additionally, individuals were numerically faster at responding when shown red compared to gray ($M = 875$, $SD = 164$). Its significance will be explained shortly. Overall, when optimism-related words were presented in red, participants identified them as words numerically faster.

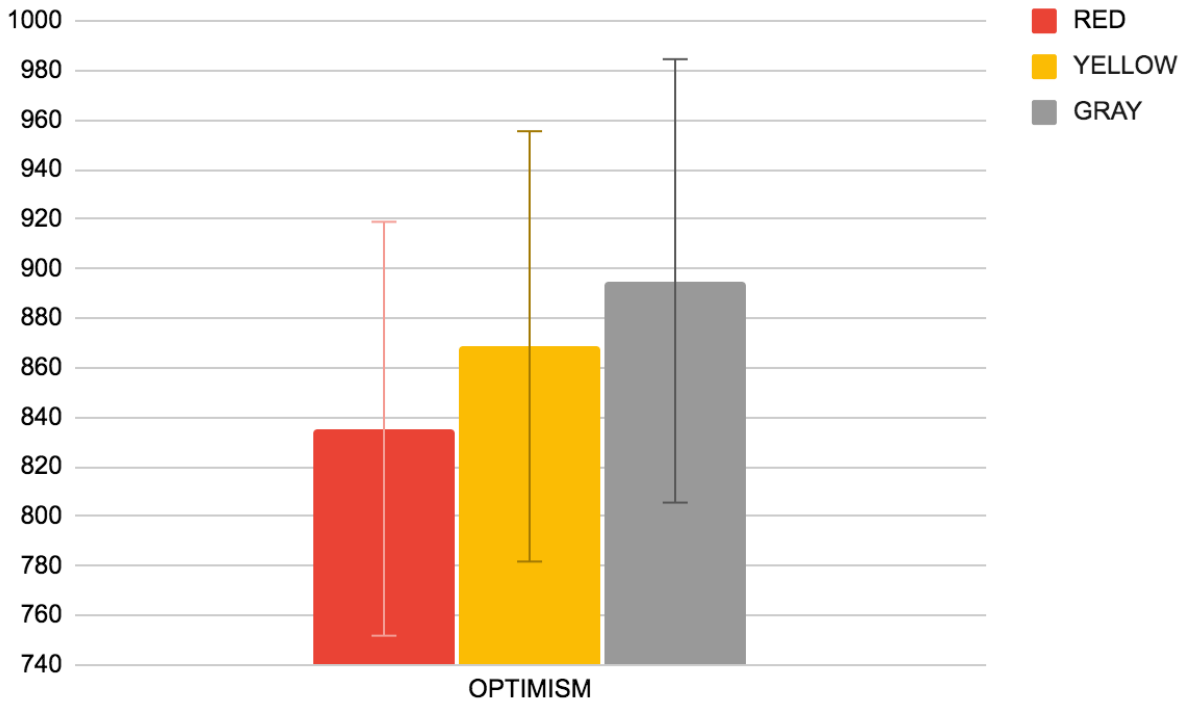

Fig. 2: Mean of all trial optimism-word related response times (ms) based on color

The effect of color was not significant for red vs yellow: SE = 19.6, $t(35) = -1.698$, $p = .220$ but there was a significant main effect for red vs gray: SE = 12.9, $t(35) = -3.057$, $p < .05$. As for yellow vs gray, there was no significant effect: SE = 22, $t(35) = -.2777$, $p > .05$. There is a significant difference between utilizing red and gray versus yellow and gray when identifying optimism-related words. This is contrary to my expected result of optimism-related words primed with yellow leading to faster reaction times.

Reaction Times - NEUTRAL ITEMS

A one-way ANOVA on Mean Reaction Times of Neutral-related stimuli with color primes as a within-subjects factor did not reach significance $F(1, 37) = .288$, $p = .797$.

As shown in Figure Three, Participants were numerically faster at identifying neutral words as words for yellow (M = 826, SD = 161) than they were for both red (M = 836, SD = 156) and gray (M = 836, SD = 181). However, the difference was not significant for both red: (M_{diff} = 9.931, SE = 18.5, t(35) = .5375, p = .853). Overall, when using red or yellow as primes before seeing neutral words, participants might have identified words slightly numerically faster in yellow than red, but statistically, this difference was not significant.

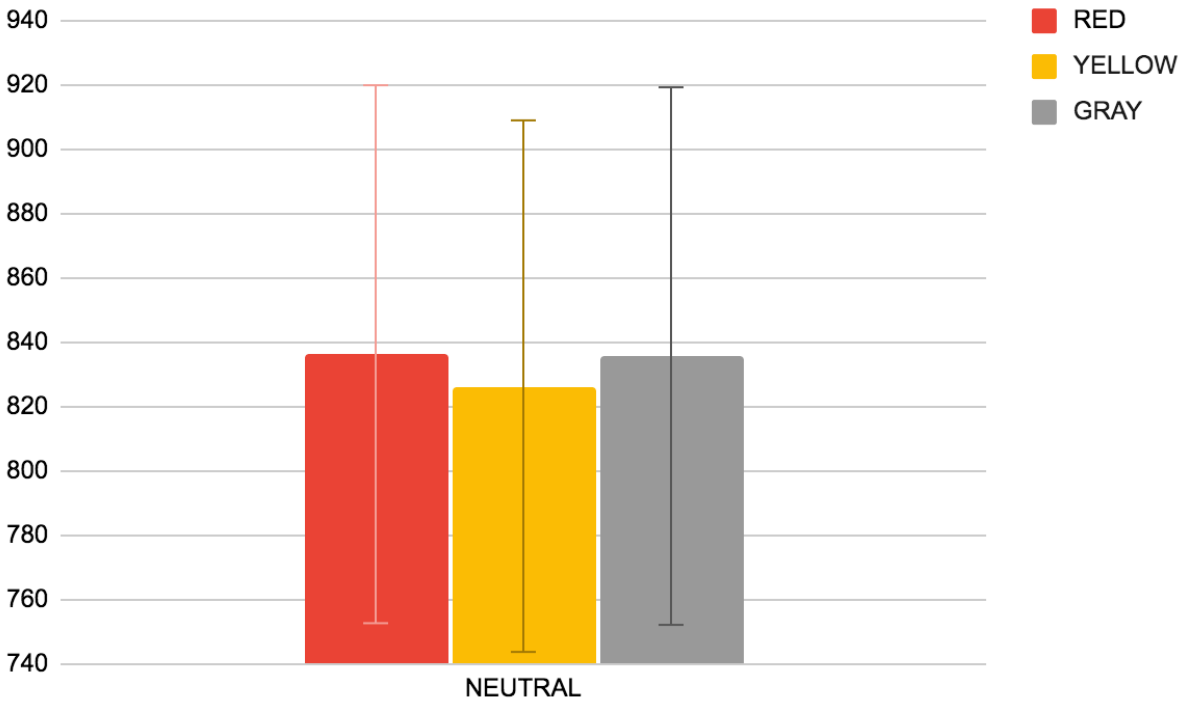

Fig. 3: Mean of all trial neutral word response times (ms) based on color

The effect of color are not only marginal but insignificant for yellow vs red (SE = 18.5, t(35) = .5375, p = .853) and yellow vs gray (SE = 17.2, t(35) = -.5441, p > .05). There was no statistical difference between utilizing any of the colors as primes when identifying neutral words as words.

Reaction Times - NONWORD ITEMS

A one-way ANOVA on Mean Reaction Times of Nonwords correctly identified as Nonwords with color primes as a within-subjects factor did not reach significance F(1, 37) = .0957, p = .909.

As shown in Figure Four, Participants were numerically faster at identifying nonwords as nonwords for red (M = 959, SD = 168) than they were for both yellow (M = 960, SD = 175) and gray (M = 963, SD = 187). However, this difference was not significant for yellow (M_{diff} = -1.29, SE = 8.12, t(35) = -.159, p = .986). Utilizing red or yellow did not make a significant difference on how quickly participants identified nonwords as nonwords.

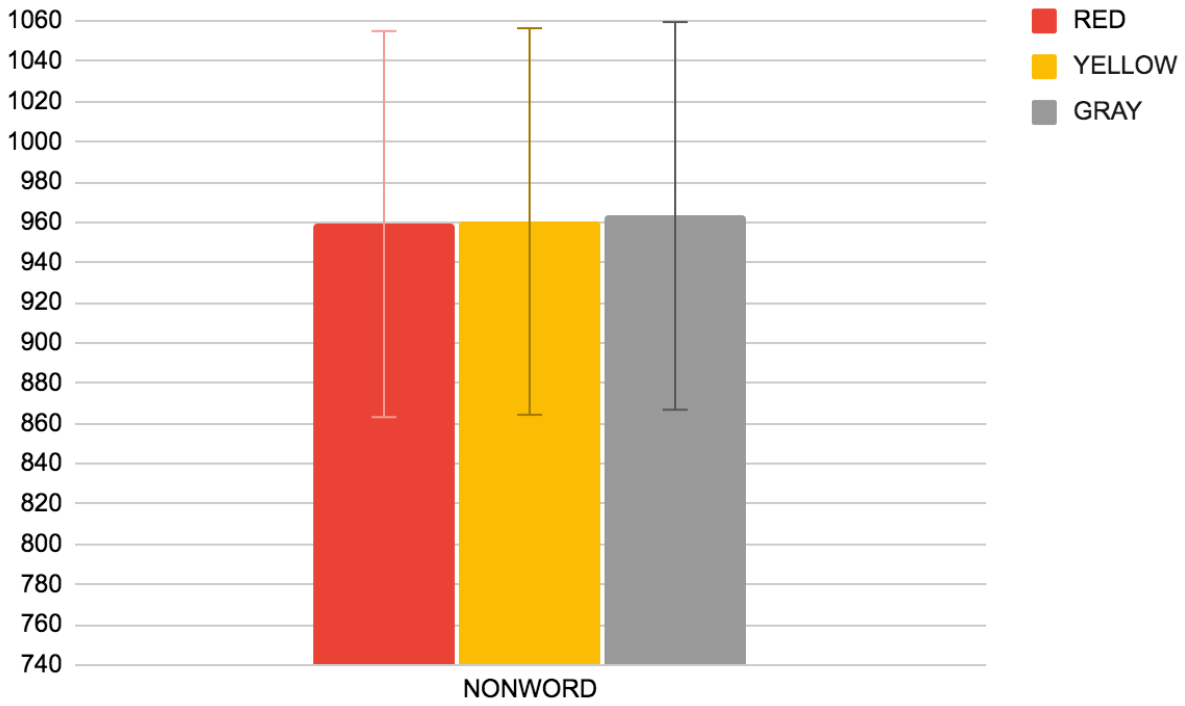

Fig. 4: Mean of all trial nonword response times (ms) based on color

The effect of color are not only marginal, miniscule but not significant for red vs yellow (SE = 8.12, t(35) = -.159, p = .986) and red vs gray (SE = 10.03, t(35) = -.406, p > .05). There was no significant difference between utilizing any of the colors when identifying nonwords as nonwords.

Discussion.

The hypothesis was based on two specific color associations, that the color red is associated with hunger and that the color yellow is associated with optimism/positivity. When these colors were used as primes in the Lexical Decision Task, words related to hunger and words related to optimism would lead to faster response times for the pair, respectively.

However, the opposite effect was the case. In comparison to yellow, red led to slower reaction times when primed with hunger-related words. But most surprisingly, the neutral color: gray, when primed with hunger-related words led to a faster response time than red and yellow. As for yellow, when optimism-related words were primed with red vs yellow, red led to faster response times than yellow, however yellow was faster than the neutral color: gray. These results conflict with Garrido and colleagues (2019) findings, because they discouraged mismatching color associations, yet my study showed better results when the word-color associations were mismatched.

Although the inverse of my hypothesis was observed in my results (hunger-related words identified numerically when primed in yellow and optimism-related words identified numerically faster when primed in red) , the findings suggest that varying the color rectangles did affect the reaction times. These findings were most significant when comparing yellow vs gray for hunger and red vs gray for optimism. Words that were always meant to be associated with a color, were in fact, directly affected by the varying colored rectangles. This is further supported by the neutral words and pseudowords with absolutely no ties to a prior color-word association, and did not lead to any statistically significant color differences. Even if the results were not the ones I expected, there is additional evidence that colors can influence our behavior, and is most evident when the words presented already carry a color-word association. Neutral and pseudowords were always intended in serving as a control factor to compare the findings too, and the fact the different colored rectangles didn't change the reaction time, emphasizes the role of varying color across certain words, whether it be hunger or optimism. The takeaway isn't that red is not associated with hunger and gray is, or that yellow is no longer associated with yellow, but instead

that these associations might be formed in conjunction with additional cues and that some colors might be associated with other words more than others.

The role of Lexical Decision Task was meant to also demonstrate the automated response time that participants have with certain word-color associations. By having a pre-existing color-word association, we would therefore be quicker at identifying a word as a word. It's supposed to serve as an additional cue to improve reaction time, but maybe the perceived color-word associations we focused on are not automatically associated. Like other contextual cues, perhaps red and hunger are not quickly associated and neither are yellow and optimism/positivity, without the usage of additional cues. Perhaps utilizing a fast food logo instead of a red rectangle by itself would've led to faster reaction times, because there's more context that could make participants automatically associate a word-hunger. Future research should look at not just other color-word combinations, but perhaps utilizing images to add further cues to explore how automatic these color-word associations are in actuality and its direct influence on response time. Garrido and colleagues (2019) modeled their study by presenting the words in the color itself, rather than flashing the color ahead of time. This could have served as a contextual cue by presenting the two with each other, and led to faster reaction times. Future research should experiment with flashing the stimulus before but more importantly, flashing it simultaneously.

It's been often stated that together red and yellow work together to make people eat at fast food restaurants, red calls their attention, induces hunger and yellow keeps them happy and brings them. But this is just an example of how the two colors in conjunction can work together, individually they create their own effects that are not dependent on one another, but when they

fall within one another, and are contextual cues to each other, they create color-word associations as a color pair. In previous studies, pairs of colors compared to other can influence our behavior and perceptions (Marques da Rosa et al., 2018), so red and yellow packaging was perceived as sweeter, that's a positive trait directly related with food preference… which individually the study aimed to deconstruct in two separate association, but these two colors might be a lot stronger together and possibly have led to different reaction times had they been paired together instead of pinned against each other. Future research should not only compare singular colored rectangles, but potentially gradients and see if certain color gradients carry paired automatic color-word associations that would be apparent in faster reaction times compared to other color gradients.

Limitations.

The sample (N = 36) is not a very large sample, and even if the other 4 responses that were removed were included, it would still not be a very large sample. Future studies should aim to recruit substantially more individuals in order to have a bigger sample size. When actively removing participants from the study, the graphs would consistently update with slightly different graphs and perhaps more participants could've drastically altered the results or at least allow us to make a more accurate generalization based on the findings.

Like many color-word associations, certain colors carry more than one association, and that was highlighted in the first half of the study. In this case, the color red is not only associated with STOP but in cases, it can serve as a STOP Cue (Garrido et al., 2019). There's the possibility that participants, when prompted with red, felt the need to STOP and take a slightly longer time

to respond to the task at hand. However, as it relates to this study, red would lead to the slowest reaction times and that was simply not the case. However, this clear association between red and serving as a STOP cue could be relevant in understanding why it led to slower reaction times when prompted with hunger-related words. A different color could've been compared alongside yellow, perhaps blue, and that would've prevented any potential effects of red acting as a STOP cue for participants. Similarly, because of the complexity of color-word associations and how they can be applicable for several words, there's the possibility that this was the case for the words we selected. Ideas of sweet and more appealing have an association with the color yellow and perhaps words like Tasty and Savory, could not only be hunger inducing but could possibly be optimism/positive related. This is supported by research conducted by Yang and colleagues (2015) which found that individuals were more likely to eat apples under yellow lighting in comparison to white, natural, lighting. Additionally, yellow lighting made it so participants perceived the apple as more intense in flavor, in comparison to blue light. Given the circumstances, even yellow can induce hunger by making food more appealing to individuals. Further research can be done looking at the overlap between words and analyzing how much a certain word can be associated with a specific color. While it could be most associated with one color, there's always the possibility that it could be associated even more. For example, in the study done by Sutton and Altarriba (2015), I would argue that when I think of the word: Moody, the color I most associate with Blue. But in their study, they found that only 22% of participants agreed, 17% thought it was more associated with gray, 13% said Red and another 13% said black. So for certain words to overlap with one another, is totally plausible and could've limited our findings.

Finally, as we established earlier in this study, associations are oftentimes formed through exposure. We tend to associate words like killer and death to the color red and that is because of its color-word association to negative items such as blood and tension. This study does not take into account any individual color-word associations that have been formed beforehand. While words that might've been designated as neutral, hunger or optimism/positive words, prior associations could've been made and could lead to varying reaction time results.

Conclusion

This study focuses solely on two colors and two singular words that are associated with each, respectively. Further research should continue to use the Lexical Decision Task to continue exploring our almost automatic responses to colors and a word followed by it. If Green can overall increase response rate (Garrido et al., 2019) what colors might have a similar effect? What colors might have an opposite effect, besides possibly red? There are so many colors and so many existing color-word associations that this study can be done over and over again, by manipulating these factors.

In conclusion, using the ideas of color psychology, pre-existing color-emotion associations, and the Lexical Decision Task, I aimed to gain a better understanding about how these associations develop. Additionally, I set out to provide additional evidence to support red induces hunger and yellow induces ideas of optimism. While this study did not provide additional evidence to support that red induces hunger or that yellow induces optimism, these associations should not be entirely ruled out. Instead, future research should continue to explore these word-color associations individually and how they may work together. Varying color can

influence behavior, and the usage of color should continue to be used in marketing and presentation. These real-word settings should explore additional color-word associations, because while one color-word association may be the strongest, they should take into account which colors work better than others, individually and together. Manipulating color can influence behavior and this should continue to be explored, but should not disregard additional components such as individual experiences and other contextual factors that could affect those associations.

References

Albert, N. M., Burke, J., Bena, J. F., Morrison, S. M., Forney, J., & Krajewski, S. (2013). Nurses' uniform color and feelings/emotions in school-aged children receiving health care. *Journal of Pediatric Nursing*, *28*(2), 141–149. https://doi.org/10.1016/j.pedn.2012.03.032

Ares, G., & Deliza, R. (2010). Studying the influence of package shape and colour on consumer expectations of milk desserts using word association and conjoint analysis. *Food Quality and Preference*, *21*(8), 930–937. https://doi.org/10.1016/j.foodqual.2010.03.006

Baddeley, A. D., and Hitch, G. (1974). Working memory. *Psychol. Learn. Motiv.* 8, 47–89. doi: 10.1016/S0079-7421(08)60452-1

Camina E, Güell F. The neuroanatomical, neurophysiological and psychological basis of memory: current models and their origins. *Front Pharmacol.* 2017;8:438. doi:10.3389/fphar.2017.00438

Elliot, A. J., Maier, M. A., Binser, M. J., Friedman, R., & Pekrun, R. (2008). The effect of red on avoidance behavior in achievement contexts. *Personality and Social Psychology Bulletin*, *35*(3), 365–375. https://doi.org/10.1177/0146167208328330

Foroni, F., Pergola, G. & Rumiati, R. Food color is in the eye of the beholder: the role of human trichromatic vision in food evaluation. *Sci Rep* 6, 37034 (2016). https://doi.org/10.1038/srep37034

Genschow, O., Reutner, L., & Wänke, M. (2012). The color red reduces snack food and soft drink intake. *Appetite*, *58*(2), 699–702. https://doi.org/10.1016/j.appet.2011.12.023

Gilbert, A. N., Fridlund, A. J., & Lucchina, L. A. (2016). The color of emotion: A metric for implicit color associations. *Food Quality and Preference*, *52*, 203–210. https://doi.org/10.1016/j.foodqual.2016.04.007

Marques da Rosa, V., Spence, C., & Miletto Tonetto, L. (2018). Influences of visual attributes of food packaging on consumer preference and associations with taste and healthiness. *International Journal of Consumer Studies*, *43*(2), 210–217. https://doi.org/10.1111/ijcs.12500

Meier, B. P., Robinson, M. D., & Clore, G. L. (2004). Why good guys wear white. *Psychological Science*, *15*(2), 82–87. https://doi.org/10.1111/j.0963-7214.2004.01502002.x

Meyer, D. E., & Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology, 90*(2), 227–234. https://doi.org/10.1037/h0031564

Minguillon, J., Lopez-Gordo, M. A., Renedo-Criado, D. A., Sanchez-Carrion, M. J., & Pelayo, F. (2017). Blue lighting accelerates post-stress relaxation: Results of a preliminary study. *PLOS ONE*, *12*(10). https://doi.org/10.1371/journal.pone.0186399

Piqueras-Fiszman, B., Alcaide, J., Roura, E., & Spence, C. (2012). Is it the plate or is it the food? assessing the influence of the color (black or white) and shape of the plate on the perception of the food placed on it. *Food Quality and Preference*, *24*(1), 205–208. https://doi.org/10.1016/j.foodqual.2011.08.011

Sucapane, D., Roux, C., & Sobol, K. (2021). Exploring how product descriptors and packaging colors impact consumers' perceptions of plant-based meat alternative products. *Appetite*, *167*, 105590. https://doi.org/10.1016/j.appet.2021.105590

Sutton, T. M., & Altarriba, J. (2015). Color associations to emotion and emotion-laden words: A collection of norms for stimulus construction and selection. *Behavior Research Methods*, *48*(2), 686–728. https://doi.org/10.3758/s13428-015-0598-8

Appendix A:

Materials Used

Hunger-Related Words	Optimism/Positivity-Related Words	Neutral Words
Tasty	Joy	Call
Snack	Joke	Rope
Crunchy	Cheer	Moon
Crispy	Friendly	Lift
Baked	Kind	Sold
Savory	Triumphant	Rain
Fresh	Laughter	Sail
Protein	Elated	Fly
Dish	Inspired	Lips
Edible	Astonished	Firm

Psuedowords

Duraters	Papul	Mincom
Fosa	Levex	Fezzle
Durrsore	Platomity	Quasion
Raez	Boaconic	Tardonts
Slimpers	Grations	Bellion
Metters	Slover	Partia
Grob	Bimmering	Smated
Quift	Ankeler	Struss
Stample	Stomative	Moderock

Crucate	Midternal	Forciner